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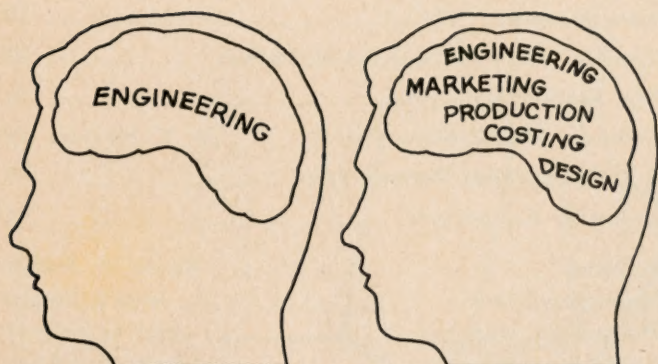
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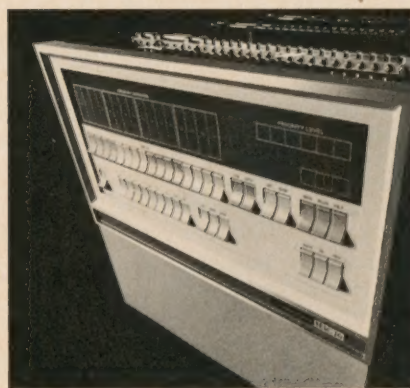
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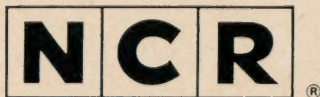
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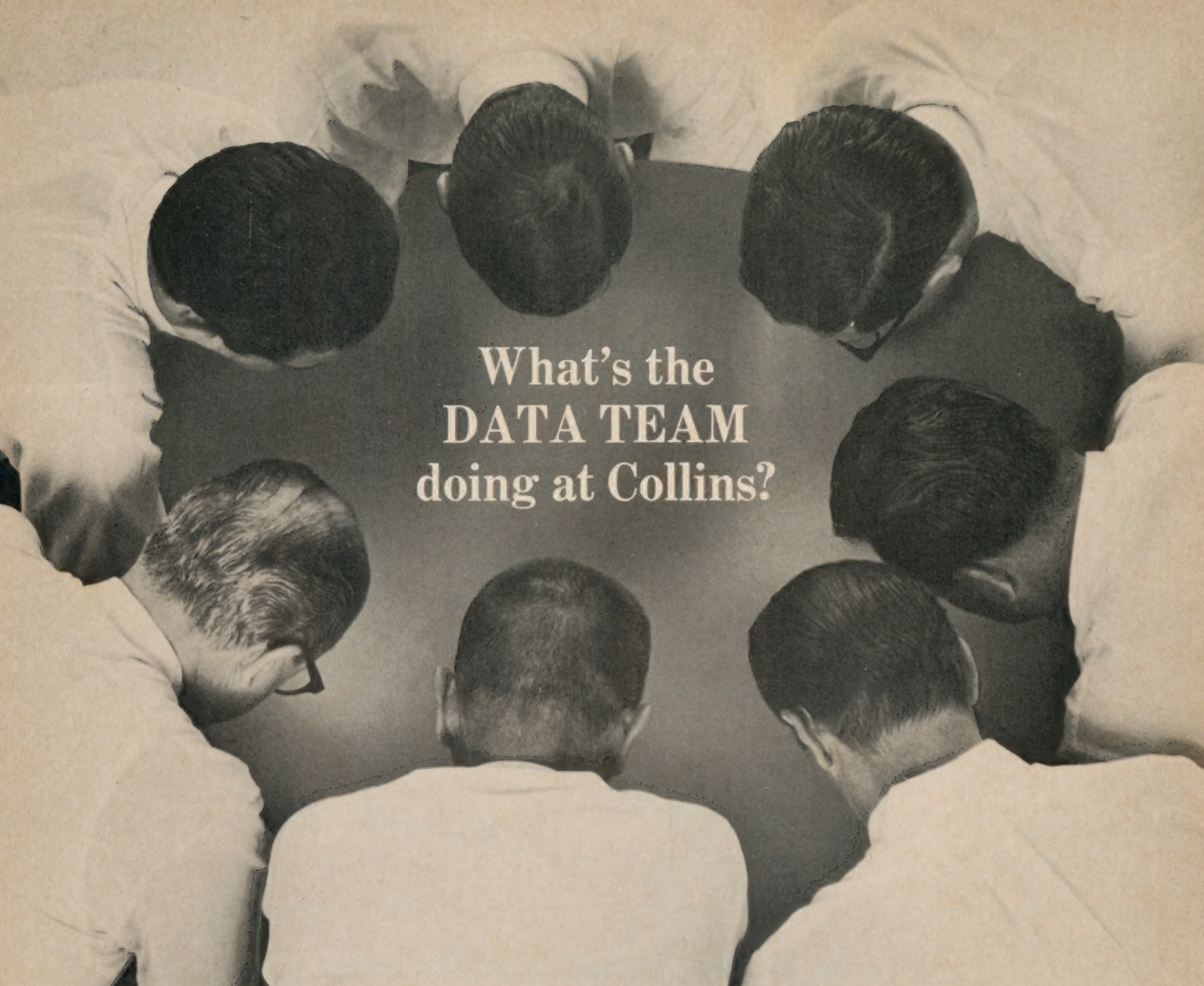
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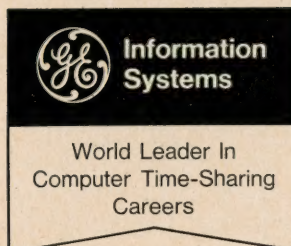
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X-Raying A Programming System

Roderick C. Billups and Louis Gordon



Billups

Billups and Gordon are presently associated with development of the documentation approach to the internal logic of programming systems for IBM, Systems Development Division, Poughkeepsie, N. Y. They both were members of IBM's first Publication Planning Group, begun in 1965.

Billups has a B.A. in mathematics from the University of Vermont. He joined IBM in 1963, and has participated in documentation support for the 1410/7010, and OS/360 programming systems.

Gordon holds a B.S.E.E. in electrical engineering from Georgia Institute of Technology. He joined IBM in 1954, and was field supervisor for maintenance of a large EDP installation, and has worked with documentation programs in internal logic as a program writer/analyst.



Gordon

Introduction

A diagnostician in the field of medicine, though knowing full well what the various parts of the body do, and that each part is made of millions of individual cells, must still use x-rays to penetrate the skin and see how the functional combinations of cells—muscles, nerves, vessels, bones—operate to determine which needs his attention. Similarly, a diagnostician in the field of programming systems needs a tool to penetrate the mass of detailed code, in order to expose the internal operations of the programming system (reflected in the manipulation of such things as tables, control blocks, queues, and lists). Given this tool the diagnostician can enter the “inner domain” with a confidence born of better understanding, and determine where remedial action is best applied. This paper describes the development of a documentation approach that provides such a tool.

To describe the documentation approach in its relation to system maintenance, we consider (1) a statement of the problem (2) requirements for improved documentation methods (3) the rationale

supporting the new documentation approach (4) the key ingredient of the documentation approach, i.e., the method of operation (5) interrelation of information and (6) how the new approach satisfies the documentation requirements of support personnel.

Statement of the Problem

In an extensive study of the documentation needs of support personnel responsible for maintaining programming systems, the following requirements were identified:

1. Diagnostic Assistance: Support personnel must be able to isolate problem sources in *many* programming systems. Internal logic documentation must show how these programming systems operate and interact internally so that decisions can be made quickly as to what area(s) require further investigation.
2. Recall Mechanisms: Support personnel are frequently involved with programming systems with which they have had no contact for a long time. Internal logic documentation

should therefore be able to quickly refresh their memory on the internal operations of a given programming system.

3. Detailed Descriptions: Support personnel often must analyze main storage dumps when trouble shooting and, at this time, need detailed information about the various tables, control blocks, and communication/work areas in the programming system.
4. Tie-in to Program Listings: Support personnel often refer to program listings for the sequence of machine instructions used to accomplish a given operation. Internal logic documentation should establish the correct sequence of code, explain how it relates to the overall operation, and further explain what tables, control blocks, and other areas are involved.
5. Time: Support personnel use internal logic documentation mainly in trouble shooting programming systems. In such cases, time is almost always critical.

Why Improvements Were Needed

In the past, when programs were fairly simple, complete operations could be brought into the main storage of the computer and executed as an entity. As a result, the documentors of the programming systems fell into the trap of deciding that the resultant physical product—the actual machine code in the program listing—reflected the program logic. They came to rely on the program listing as the logical basis for the development of the necessary documentation. That is, the documentors came to stress the way code is broken into segments and to relate what goes on within those segments. They tried to discuss function/operation to some extent, but became more and more dependent on what the various instructions in a given segment of code were doing and how the instructions were tied together to accomplish some specific function/operation.

As programming grew more sophisticated and complex, the ever-present storage restrictions grew more binding. Complete operations in many cases could no longer be brought into main storage at one time. (See Figure 1). Programmers, in their desire for more efficient program performance, used the main storage available after the storage requirements of the main function had been met, as a place to unload bits and pieces of other functions. This meant that one physical load (a major program segment) often contained pieces of many different functions. Because the documentation was developed around these program segments rather than around function or operation, the program logic was buried deep by a disjointed presentation.

Rationale for Method of Operation

A study of the requirements for improving internal logic documentation resulted in the conclusion that even though the documentation must show the structuring of a program into its coded segments, it must not obscure the underlying logic to the extent that support personnel would be unable to understand *why* certain things happen.

It appeared that the most logical

step was to develop internal logic documentation in a manner paralleling the natural development of the programming system itself. Developed on this basis the documentation would, it was believed, definitely enhance understanding of the total internal logic.

In the development of any programming system, the first requirement is to determine objectives that are to be accomplished. Only then

can the actual planning of the programming project get underway. Programmers must consider the types of input to be handled and the outputs necessary to attain the overall objectives of the system.

To get from the specified inputs to the desired outputs (see Figure 2), certain functional operations—such as reading in and processing the contents of control cards—must be performed. Because these func-

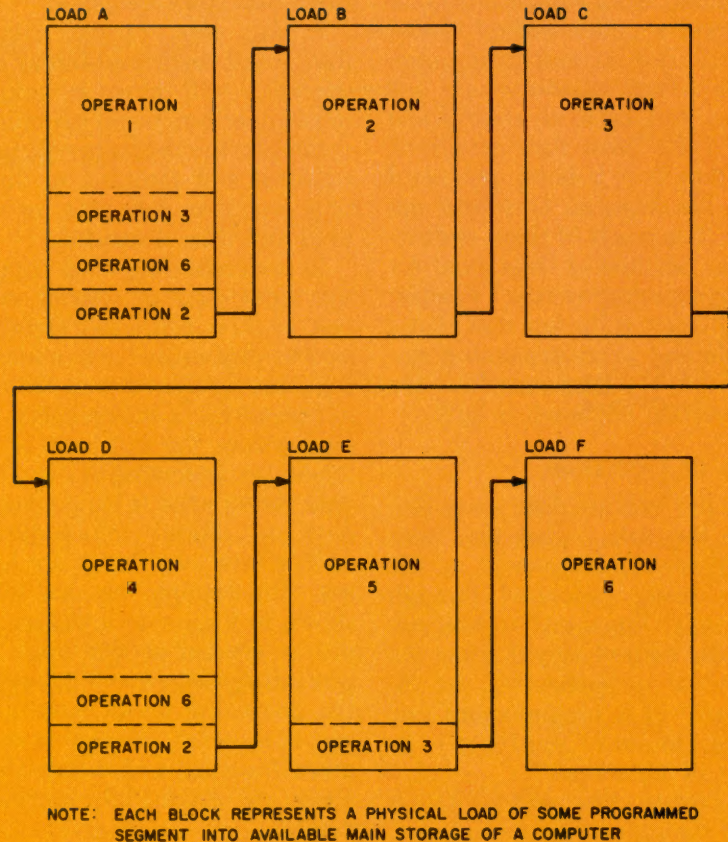


Figure 1

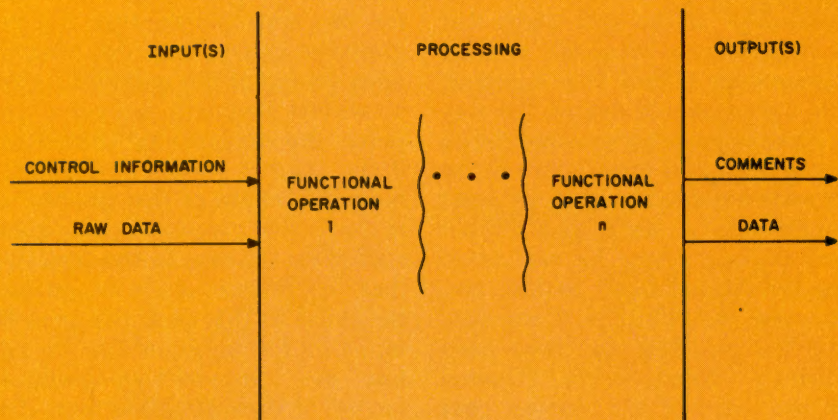


Figure 2

tional operations form the basis of development for the programming project, the programmers must consider the operations that are to be involved as early as possible in the project.

A question that must be asked is: "Do programmers—knowing merely what operations are needed—immediately start writing the code that will allow them to run their program on the computer?" The answer is "No."

If not code, what is it then that programmers work with at this time? The answer is tables, control blocks, work areas, queues, and communication areas. Programmers create and use these *data areas* to control and to record the input data or control information as it is being processed through the required functional operations. The result of these endeavors is the "Method of Operation" for the programming system. Realization of this fact is the key that allows understanding of programming systems, and is the base on which the documentation approach is built.

Method of Operation

What the various data areas are, the role they play, what they contain, and how they interact as the input is being processed through the various functional operations toward the desired output, form the rationale for understanding the internal logic of a programming system and, in fact, represent its "Method of Operation."

To resolve the documentation needs of the support personnel, documentation on the internal logic of a programming system must reveal this "Method of Operation." Operation diagrams—x-ray photographs of a programming system—should be developed to picture the uses and relationships of the data areas that the programmers establish in their programming system. For example, when a programmer designs the way the input to his programming system is to be processed (see Figure 3), he will want a defined part of his input brought into a work area (Input Work Buffer) where he can determine the type of input he has, perform some processing on it, and then place that modified input into some temporary storage area (Section List)—a form of the various data areas mentioned previously. Assuming that the programmer refers to

this particular operation as "read-in," he now has determined, using specified data areas and designating the function of each area, how the input (either data or control information) will be brought in and processed.

At the beginning of a programming project, the programmer has a fairly good idea of what functions the various data areas should fulfill, but he probably will not have defined the format that the entries into these data areas will take. As ideas firm up, format definitions become more and more specific.

In any case, various data areas that result from the initial read-in operation will serve as input to a subsequent functional operation. Accordingly, the contents will again be modified and returned to the same or some other data area, or will be used and then discarded.

In understanding what happens to the input data or control information as it is processed through the various data areas (or in understanding what is referred to as the method of operation), a maintenance person understands the real logic of a particular programming system. He not only knows what is happening to the data or control information, but understands *why* things are happening. For example he sees why (as shown in Figure 4) a particular format is needed at this stage in the processing, where critical points in the processing occur, how the various data areas interact to fulfill a given function, and where the data areas are originated, modified, or deleted.

Extending the Documentation Approach

Understanding the method of operation is the key to understanding the total program logic. However, for the same reason that the programmer cannot stop the programming project at this point if he wants a product that will run on a computer, the documentor cannot stop if the support personnel responsible for maintenance of that product are to have the proper documentation tool to do the job. In the same way that the programmer's design must be coded so that such things as the input to his program can be read into the computer, an additional section of documentation must show how the program is broken into its segments, what segment of code per-

forms what function, how control flows from one segment of code into another, and what program segments are in main storage at any given time.

Interrelation of Information

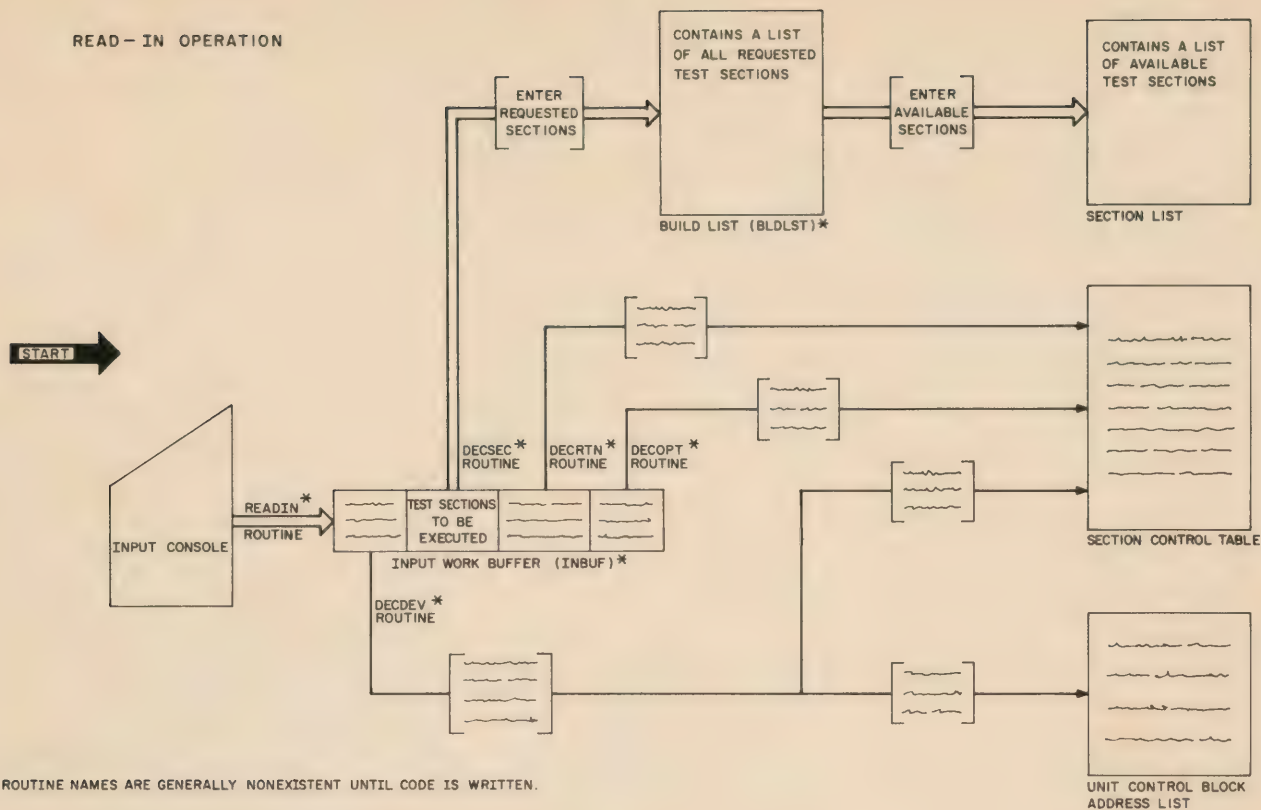
In the same way that the programmer must relate function to code, the documentor must relate information concerning the method of operation to information about segments of code, that is, the organization of the code or programming system.

Assume that the programmer is prepared to start writing code. Logically, he starts at the beginning of an operation and determines that he must write code to implement each step within that operation. Assume also for the read-in operation in Figure 3, that the programmer writes code to allow the computer to read a certain amount of input into the work area. In the process, he gives that sequence of code a symbolic name (in this case, READIN). Similarly for the rest of the steps, such names establish a tie-in of (1) the steps of an operation as depicted with operation diagrams in the method of operation documentation with (2) the actual code written to implement those steps. In this way, the documentation about method of operation is related to associated documentation about program organization.

But, what if the support person wants to determine what part some symbolically named segment of code plays in its associated functional operation, how it interacts with other segments of code, and what its inputs and outputs are supposed to be? He does not want to search through all the operation diagrams to find the symbolic name in question. This is a situation where a way is needed to show how the code is broken into program segments to allow it to be loaded into main storage, how control flows from one such segment to the next, and what names are given to the various segments. For this, the traditional flowcharts suffice.

From a maintenance point of view, knowing which program segment has control is useful and often necessary information, but ordinarily is not sufficient to pinpoint the source of a problem. In itself, this type of information does not allow the use of solid deductive reasoning

READ-IN OPERATION



* ROUTINE NAMES ARE GENERALLY NONEXISTENT UNTIL CODE IS WRITTEN.

Figure 3

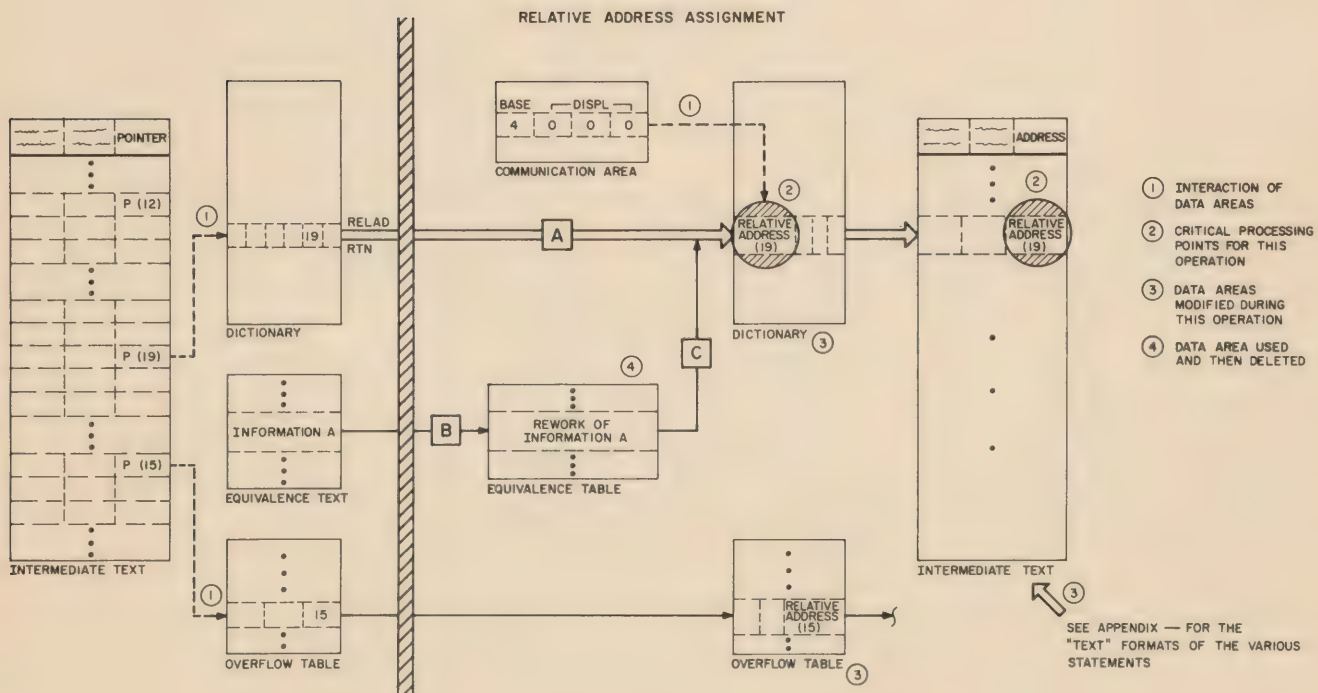


Figure 4



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based on understanding how this program segment fits into the scheme of the functional operation. This information is correlated with the operation diagrams by putting the name of the functional operation with which this segment is associated, right on the flowchart. Now a two-way flow is established for referencing information—from method of operation to program organization, and vice versa.

It is important to note here that for maintenance work on programming systems, any one piece of information usually is not sufficient; rather, a correlation or relation of different types of information is needed to give a complete picture. In addition to that already discussed, another time saving technique is the use of a *directory* to relate information (see Figure 5).

With the information available in the method of operation and program organization sections of documentation, there should be no difficulty in locating a specific section of coding in the program listing.

Various manufacturers may have different means for distributing the program listings, and they must compensate in their documentation for associated peculiarities that make finding information in the listings difficult. For example, IBM uses Microfiche as its distribution medium. In its documentation, therefore, it has become necessary to provide additional information in the directory just mentioned to identify the Microfiche cards which contain the various segments of the program listing.

DIRECTORY

SYMBOLIC NAME	DESCRIPTION	OPERATION	CHART ID
DECDEV	DECODE DEVICE ROUTINE	READ-IN	AC
DECSEC	DECODE SECTIONS ROUTINE	READ-IN	AB
DECOPT	DECODE OPTIONS ROUTINE	READ-IN	AE
SECCNT	SECTION COUNTER ROUTINE	TEST CONTROL	CD
⋮	⋮	⋮	⋮
SECLST	SECTION LIST	READ-IN	AB

With regard to relating information, one further item remains to be addressed: the detailed layouts of the data areas required by the program. Historically, these detailed layouts have been provided in documentation of internal logic. The layouts show general formats of the contents, usage of (and reasons for) specific fields, and the displacement of the various fields from the beginning of the data area.

When main storage dumps are taken at the time a problem occurs, such detailed layouts are essential in analyzing the dumps. Equally important is the requirement that support personnel attempting to analyze the problem know where the data areas fit into the scheme of things at the time a particular operation is being fulfilled. This type of understanding allows that person to use his own reasoning along with his understanding of the program logic and organization (or structure) to achieve a quick solution to the problem at hand.

This relationship is easily statified by expanding the scope of the directory to include data areas (e.g., SECLST in Figure 5). By scanning this directory, the operation(s) with which the data area is associated can be found. It is then only a matter of reviewing the diagrams associated with the operation, remembering that these diagrams are developed around the interaction of the various data areas. If necessary, the associated flowchart can also be determined.



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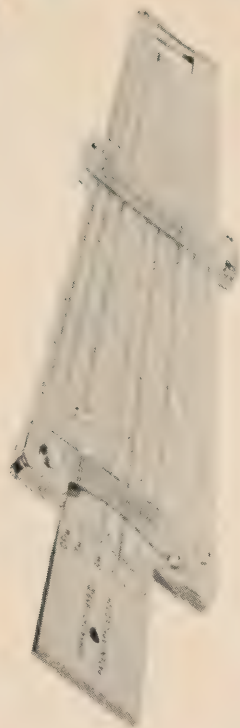
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**Satisfying the Documentation
Needs of Support Personnel**

The documentation approach, built around the method of operation, was developed to satisfy the documentation needs of support personnel in the area of programming systems' internal logic. To show how the documentation approach satisfies those needs, the following five points are addressed in the same order as presented at the beginning of this paper.

1. *Diagnostic Assistance*: Referring again to the diagram in Figure 4, it is well to recall that each functional operation has an input, performs some processing, and produces a result or an output. Briefly stated, a logical progression exists from the input to the output, and the interaction of the various data areas (as the input data or control information is being processed) can be determined. Associated with this processing is the corresponding symbolic name of the coded segment that actually executes a given step in the operation within the computer (e.g., RELAD routine in Figure 4).

The information given in such diagrams allows support personnel to analyze inputs and outputs of various processes, the effect of one step on another in an operation, the effect an entire operation has on another operation, the critical processing points, the interaction of data areas, and the code that is involved.

Also, if the programming system has the facility to provide main storage dumps at designated points, an excellent checkpoint can be developed by incorporating in the documentation (most likely in an appendix) the *exact* contents of the various data areas that constitute for a given program the output of each functional operation. This information allows the storage dump contents to be compared with the exact data area formats in an appendix. If some particular piece of data does not match its counterpart in the output of a given operation, a check of this same data can be made with the output of the preceding operation(s). The trouble is thus isolated to the operation in which the data first appears incorrect. With the diagram for that operation, support personnel can



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use the information to pinpoint the problem more accurately.

Another aid in isolating a problem area is the technique of cross-referencing information among the various sections of documentation. In tracking down a problem, support personnel can get to a certain point—for example, in the method of operation discussion—and find that still more information is needed about the relationship between the particular code involved and how it fits into the flow of control in the programming system. The documentation is so organized that it allows the particular segment of code involved to be pinpointed within the program organization discussion.

2. Recall Mechanisms: An operation diagram, as illustrated in Figure 4, serves as an efficient recall mechanism, because support personnel can use the diagrams to quickly refresh their minds as to what the functional operations are, what the inputs to each operation are, how these inputs are processed through the operation, and what output is produced by the operation. As support personnel review this process, they may not remember what goes on within a certain step of the operation. The diagrams provide them with a reference point (e.g., reference point A in Figure 4) to that particular topic in the narrative text, which supports the diagram. This approach is considerably faster than trying to read words only.

3. Detailed Descriptions: This documentation approach incorporates the required detailed layouts of data areas, such as tables, control blocks, queues, and communication areas.

4. Tie-in to Program Listings: This documentation approach incorporates a means of getting to a specific sequence of code in the program listing.

5. Time: The most important requirement for support personnel maintaining programming systems is to perform their job in the least amount of time. This need for the reduction in time was a prime consideration as the scheme for organizing and presenting the information in the documentation was devised and developed. ■

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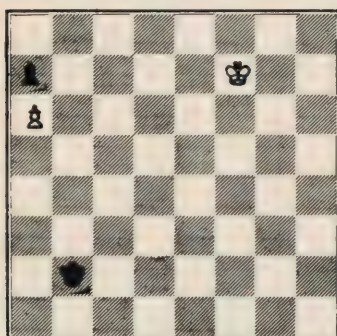
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CHECKMATE

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Problem 9

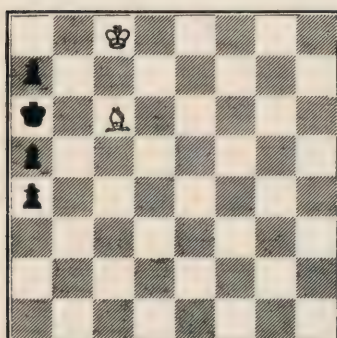
MAISELIS 1921



White to play and win

Problem 10

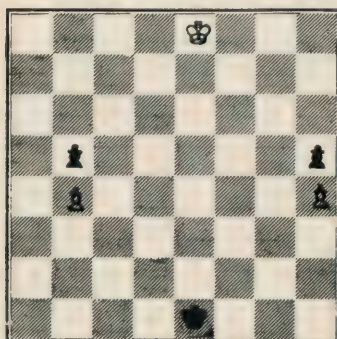
SACHODAKIN 1932



White to play and win

Problem 11

GRIGORIEV 1929



White to play and win

THE END GAME

A good opening is always important in chess, and it does not take much effort to memorize several variations of your favored openings and play the first few moves by the book. Of course, you can afford to take chances in the opening and there is always hope that you will be able to recover the ground that is initially lost if you have a bad opening.

In the-end-game you can not afford to take chances. Every move is critical and in many games the sequence of moves is of paramount importance. Many games end in a draw because a player fails to recognize a clear-cut victory, or recognizes a victory and hastily proceeds with the wrong sequence of moves.

The basic objective in the-end-game is to promote a pawn and make it a queen. Problem 9 illustrates that a straight line is not always the shortest distance between two points. Problem 10 illustrates the power of a bishop if it is used wisely. Problem 11 illustrates the pressure the white king can exert on the black king even though they are separated by the length of the board.

IS THERE A DOCTOR IN THE HOUSE?

How would you feel if you call your doctor in the middle of the night and you are told he is playing chess in Venice, Italy. Of course, if you are a patient of Dr. Anthony Saidy of Los Angeles, you probably know that your doctor is also one of the top ten players in the United States and has an overriding ambition to gain an international title, for which he practically had to go to Europe.

Dr. Saidy and Pal Benko spent several months in Europe recently making the rounds of chess tournaments. Benko of course is already an established international grandmaster and playing tournament chess is the practice of his profession.

After a number of attempts, Dr. Saidy finally made it in the third annual grandmasters tournament in Venice. He is now an established international master and will probably go back to Europe next year to fight for the title of grandmaster. GOOD LUCK DOCTOR!

Here is a game in which Dr. Saidy trapped his opponent's bishop and finished with a win.

SAIDY (USA) (White)	TALAI (Italy) (Black)	SAIDY (White)	TALAI (Black)
1 P-Q4	N-KB3	21 QxR	Q-N3
2 P-QB4	P-K3	22 Q-B3	N-K4
3 N-QB3	B-N5	23 P-QN4	BxBP
4 P-K3	P-B4	24 R-KB	B-K6
5 KN-K2	PxP	25 R-K	B-B7
6 PxP	O-O	26 R-K2	B-N8
7 P-QR3	B-K2	27 P-KR4	K-B
8 P-Q5	PxP	28 N-R3	Q-N4
9 PxP	R-K	29 NxB	QxPch
10 P-KN3	B-B4	30 N-B3	R-K
11 B-R3	P-Q3	31 Q-K3	P-B4
12 BxB	QxB	32 R-Q2	Q-B3
13 O-O	Q-N5	33 Q-B3	Q-K5
14 K-N2	QN-Q2	34 R-KB2	R-K2
15 P-R3	Q-QB5	35 Q-Q4	Q-B3
16 P-N3	Q-R3	36 P-N5	QxP
17 B-N2	N-K5	37 QxQP	NxN
18 NxN	RxN	38 B-B6	N-K8ch
19 N-B4	P-KN3	39 K-R3	Resigns
20 R-K	RxR		

Solutions to last month's problems appear on page 37.

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by Dennie Van Tassel

COMPUTERS IN THE SERVICE OF MEDICINE edited by Gordon McLachlan and Richard Shegog. Volume 1. Oxford University Press. 1968. \$3.50.

This book contains twelve articles that focus on computers for medical use. Half of the articles discuss the processing of hospital records, and the other half with the handling of medical tests. None of the articles will appear technical to computing people who have some experience in the medical profession.

Some of the subjects covered in the first half of the book are the following: Introducing a computer to a hospital, Electronic processing of hospital records; Identification of patients and their records. The second half of the book discusses the use of a computer-based system for handling of clinical data, electrocardiogram interpretation, clinical biochemistry data, drug monitoring, and drug prescribing.

This book should not be considered an elementary text and probably will be read by few in its entirety but a reader can pick and choose the articles of interest without any loss of continuity. The book does contain a great deal of information and is a very valuable reference book.

PROGRAMMING SYSTEMS AND LANGUAGES edited by Saul Rosen. New York: McGraw-Hill Book Company. 1967. 730 pages. \$12.50.

Programming Systems and Languages is a collection of articles which appeared in computer journals, and which, in the opinion of the editor, Saul Rosen, is tutorial, and offers something of interest to every software expert but will offer little to any layman. Many of the articles are concerned with describing the major programming languages and giving some historical information about the languages.

The book is divided into five parts each having many separate sections. Part 1 is a brief historical survey of the development of programming languages. Part 2 contains articles on the four major programming languages: FORTAN, COBOL, ALGOL, PL/I. These articles mainly describe the languages and give a little historical information. Part 3 covers translators and compilers for languages—mainly of the type discussed in Part 2. The best-known of the list processing and symbol manipulation languages are covered in Part 4. Operating systems, starting with the old batch processors and proceeding up to the recent time-sharing systems are covered in the last part of the book.

GAME THEORY by Guillermo Owen. Philadelphia: W. B. Saunders Company. 228 pages, 1968, \$9.00.

Game Theory is a theoretical text on games. This book will be of interest only to people that have a definite serious interest in the subject of games. This is not to say the book is difficult to read, because it is not. While the book is written from a mathematical point of view, the author states that the book is designed for college undergraduates. Elementary probability theory, some calculus, and some abstract measure theory are necessary for understanding this book. The author includes a few pages on convex theory and functions for readers who are unfamiliar with these two subjects.

Basically the book is divided into two sections, two-person game theory and n-person game theory. Some of the topics, but by no means all, discussed are: zero-sum games, linear programming, infinite games, utility theory, and general sum games.

BUSINESS INTELLIGENCE AND ESPIONAGE, edited by Richard M. Green, Jr. Homewood, Illinois: Dow Jones-Irwin, Inc. 312 pages, \$12.95.

This book is a general introduction to the field of business intelligence. Not only is the more glamorous area of industrial espionage discussed, but also the field of business intelligence

is explained. Business intelligence includes collecting information for news releases, stockholder reports, letters of inquiry, discussions with customers and friends, and reading scientific papers. The book covers both how to gain and prevent business intelligence. A good deal of the book is devoted to discussion of the available sources of business information, which are often overlooked. One chapter of the book covers the building of an automatic information system for business intelligence and although the article is rather short because of the uniqueness of the problem, some valuable information is given.

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Career Planners: DATA PROCESSING & MANAGEMENT SCIENCES

THE IMPACT OF COMPUTERS ON MANAGEMENT, edited by Charles A. Myers. Cambridge: the M.I.T. Press. 1967, 310 pages, \$10.00.

It is probably safe to say that today no business firm is unaffected by computers, even a small business often fills out order forms which are processed by a computer and has its bookkeeping done at a computer service bureau. This book discusses the present and future impact of computers on management organization and the nature of managerial work.

The volume is a collection of papers which was presented for a research conference convened by the Industrial Relations Section of the Alfred R. Sloan School of Management at the Massachusetts Institute of Technology in 1966. The majority of the papers are written by academic scholars who have studied the effects of computers in business organizations.

Here are some of the central themes that were discussed and the conclusions: Information technology has centralized control in organizations. This centralization includes

routine tasks such as accounting, production, and supply management. Is centralization a necessary result of computerization? One conclusion was that organizations that choose the path of centralization at the expense of individual initiative and creativity may not be able to reverse themselves and will probably lose out competitively to more enlightened forms of organization.

What is the significance of centralization of the data-processing function? Even though the data-processing function is often "neutral" in the sense that it is not attached to another functional area such as accounting or finance it is unlikely that one can continue to hold title to the computer without assuming and using the effective power that it confers. One rather amusing discovery was system people often tend to design a system for the benefit of the programmers and not for the purposes to which the company is devoted.

Several not too surprising conclusions were drawn on the changing nature of managerial work under computerization. Computers take

over much of the middle management routine work and leave time for managers to deal with unstructural jobs that were not getting done before because these managers were too busy. Man-machine inter-action systems, using time-sharing computer technology, will become increasingly important to higher management levels. Top management will also become more research and systems oriented and will increasingly come from positions with these backgrounds.

The book does not cover the technical aspect of information science, but instead concentrates on the impact of information technology. Too often this aspect is ignored and great effort is expended in the technical section and little or no energy is spent on the people aspect even though it is usually the latter that may cause the failure of the system.

GAME PLAYING WITH COMPUTERS by Donald D. Spencer. New York: Spartan Books. 1968, 441 pages, \$12.95.

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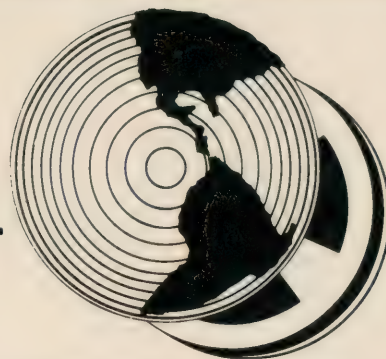
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This is evident since computerized game playing may be found to some degree at almost every computer installation. Game playing is not wasteful, since information gained from programming computers to play games is directly transferable to other areas of scientific and business programming.

This book discusses more than 70 games, puzzles, and mathematical recreations that may be programmed for a digital computer. Many of the more simple games have complete programs, including flow charts, provided for use. The games are programmed in either FORTRAN or BASIC. Some of the FORTRAN games or puzzles which are programmed are magic square, prime number, binary games, pick-a-number, 4-by-4 puzzles, Blackjack, counterfeit coin, checkers and kings.

Programmed games in BASIC include Sieve of Eratosthenes, magic square, prime numbers puzzles.

Most of the more complicated games, such as checkers, chess, Keno, are just discussed and suggestions are given (some with flow charts) as to how to program the games. The book offers quite a few

programmed simple games, but much of the book is filled with just descriptions of games instead of actual programs. But the book is still sure to stimulate much interest around the computer room, and the cover itself is no less exciting.

COMPUTER SELECTION by Edward O. Joslin. Reading, Massachusetts: Addison-Wesley Publishing Company, Inc. 1968, 172 pages, \$7.95.

Often when the time comes to select a new computer it is too easy to select Number One or the manufacturer of your old computer. In the past, one reason for not changing manufacturer is that one would have had to reprogram everything and this was too expensive. Now, however, that standard programming languages (COBOL and FORTRAN) are widely in use, this factor is becoming less of a problem.

This book is an attempt to overcome the second problem; that is, the problem of evaluating several new systems. Many times installed computer systems have not lived up to their expectations simply because the proper system was not selected for the jobs to be done.

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Here are some of the topics discussed: Specifications for Computer Systems; Techniques of Evaluating Proposals; Methods of Procuring Computer Systems; Preparation for Validation and Adjustments; A Selection Example. The book is well written and should be read by anyone considering replacing his present computer system.

CONVERSATIONAL COMPUTERS by William Orr. New York: John Wiley & Sons. 1969. 227 pages. \$8.95.

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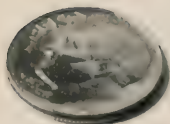
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Mankind had several hundred years to get accustomed to the automobile. First there was the sled, then the wagon, later on the wagon was hooked up to animals. During the nineteenth century steam power was added and in the present century the internal-combustion engine brought about the development of the personal passenger car.

In contrast mankind has had only 20 years to become accustomed to personal computers and according to William Orr, personal computers will have an effect on all of us that will be at least as profound as the effect of personal passenger cars.

Conversational computers will come as no surprise to the computer profession but it is doubtful if the general public is aware of their potentialities or ready for the cultural shock they are about to experience. This book is an attempt to introduce conversational computers to the intelligent curious non-specialist. The book will also be of interest to the specialist. A wide range of present uses of conversational computers are discussed, but voice conversation is not discussed, because according to William Orr, the state of the art permits only the grossest of speculation now and for several years to come.

The subjects covered are: Problem-Solving Modes; Instructional Modes; Retrieval and Query Modes; Graphical Conversational Modes; Toward the Computer Utility; and Psychological and Social Implications.

In the past rigid demands of production programming, together with high computer costs and unacceptable time lags, combined to inhibit the free play of imaginative human intelligence when it is tied to a computer system in the conventional manner. Conversational computers, with their advantage of instant response and mass information systems promise to eliminate much of the past restraints of clerical feasibility, high cost, and information hunting, and allow man to concentrate on digesting information at his top most intellectual ability. Whether man is ready for this or not, the possibility is at hand. ■

Suggestions for book reviews and requests for further information should be addressed to: Book Review Editor, Software Age, 2211 Fordem Avenue, Madison, Wisconsin 53701.

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Dick F. (M.S., Physics) is generating prize-winning plots on our CalComp Zip-mode plotter while studying image enhancement

Norm (M.S., Meteor.) is developing a multi-band spectral simulation system

Ray R. (B.S., Aero.) is working on scanner-computer integration

Ron G. (M.B.A.) is writing an information-retrieval system

George N. (B.S., E.E.) is describing a numerical control language — Stan (B.S., Ed.) and Tony (B.S., Physics) are helping George

Randy D. (M.S., M.E.) is simulating optical systems to compute production tolerances

Ed C. (B.S., Math) is writing a process-control real-time monitor system. Ted (B.S.) is helping Ed.

Russ (working on B.S.) is solving thermal and thermal-structural problems

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_____ is analyzing optical systems in dynamic environments

If you can fill any of the blanks or can help in any of the other areas, see us at the Sheraton Boston Hotel during the Spring Joint Computer Conference. If you can't make it, drop a resume in strictest confidence or call Mr. Ed Mulkern, (617) 236-2030.

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new products

Four additional main storage sizes—up to double the present memory capacity—have been announced for the IBM System/360 Model 65 multiprocessing system.

The new storage sizes range from 1,310,720 to 2,097,152 bytes. Present storage capacities range from 524,288 to 1,048,576 bytes.

The multiprocessor combines two Model 65s which operate under one control program. They share storage and peripheral units. The Model 65s may run as a single multiprocessing system or as separate stand-alone systems with up to one million bytes of storage each.

For more information, circle No. 9
on the Reader Service Card

A new printout system, the Clevite 4800, has been developed by the Clevite Corporation. The electrostatic hard copy printer for computer systems provides accurate printouts—including charts and drawings—as quickly as the computer supplies them. The machine can simultaneously handle alphanumerics and graphics—"anything the computer can generate".

The electrographic recorder produces hard copy readout of computer solutions in less than one second for each 8 $\frac{1}{2}$ " x 11" page. Through its "unique" matrix system, the Clevite 4800 delivers 4,800 alphanumeric lines per minute or 412,000 characters a minute. The printer repro-

duces signals from any source of digital input or data transmission by telemetry, radio microwave and/or land line. Further features of the printer include: distortion free alphanumerics and graphics, and immediate dry and permanent copy.

For more information, circle No. 10
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Computer scientists at Illinois Institute of Technology, Chicago, have developed a system for communicating with a computer in three foreign languages, Spanish, French and German, from inexpensive remote teletypewriter terminals.

The three corresponding computer languages are known as SPANTRAN, GAULTRAN, and DEUTRAN. They employ translated words and sentences from the IITRAN system, a language developed at IIT, designed for communicating with computers during high school and college classroom computer use.

These new languages should prove valuable to students in other countries studying at the college, high school and even the elementary school level who cannot speak or write English, since the commands are given and received in the students' native language. This eliminates the need to learn the English language before learning to use a computer.

The new system can be adapted to any language which uses letters of the English alphabet. In the event that a translation is desired into a language using letters not found in the English alphabet, a simple adjustment can be made in the type fonts of the printing mechanism.

For more information, circle No. 11
on the Reader Service Card

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Daedalus Computer Products, Inc. has announced a new Digital Inter coupler Model 210.

The Inter coupler is a versatile integrated circuit unit for coupling electronic instrument outputs to peripheral equipment such as Teletype equipment, card punches, incremental mag tape recorders, printers and line printers and typewriters. There are also optional features which enable the Model 210 to be used simultaneously to drive two output devices such as a paper and card punch, or a paper punch and digital printer.

Daedalus' 210 Digital Inter coupler is capable of receiving coded data from standard measuring equipment—DVMs, counters, scalars, timers—and translates

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Planning to attend the SJCC in Boston May 14-16? Then drop your resume in our box at the Software Age resume center at the Statler Hilton Hotel. Or forward your resume to Mr. John J. McMahon, ITT Defense Communications, 492 River Road, Nutley, New Jersey 07110.

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the data into a computer compatible form to drive the readout devices.

The Inter coupler can be rack mounted and stands 5 1/2" high, 19" wide and 17" deep. Typical operating speeds range from 10 characters per second to 100 characters (depending on the output device).

For more information, circle No. 12
on the Reader Service Card

* * *

Deibold Inc. announces the development of a **Data Safe** for the storage of magnetic tapes, disk packs, sensitive cartridges, micro-fiche, and EDP media. The Diebold Data Safe is a pressure-sealed, sleek-lined vault designed to protect and secure information that may have been collected over several years. It offers maximum security against fire and moisture with an allowable heat limit of 150° F.

An inner repository "floats" within the outer safe on a bed of insulating foam so that it won't touch the exterior walls. A pressure locking mechanism seals the insulated inner doors from heat and moisture. The outer wall is protected by a heavy wall of Monolite insulation, a material which leaves no space for heat to penetrate.

The safe has received labels of approval from the Underwriter's Laboratory and the Safe Manufacturer's National Association. It is available in two sizes with a variety of locking features.

For more information, circle No. 13
on the Reader Service Card

Synergistic Software Systems, Inc., of Houston, Texas, has announced the availability of "**FILEMAKE**", a new program debugging and testing aid. This pretested software package gives application programmers the ability to automatically generate validating test data while reducing machine usage and program checkout time.

FILEMAKE validation is accomplished by using data subsets instead of entire "live" files. This feature saves machine time, provides a more thorough check-out of program logic, and saves programmer time by automatically isolating erroneous routines.

FILEMAKE is compatible with FORTRAN, COBOL, PL/I or ALC under DOS/OS, and allows specification of either fixed or variable length records, automatic data generation at the field level, controlled record repetition and reusable record structure. It requires 24 K bytes.

For more information, circle No. 14
on the Reader Service Card

* * *

LOGIC CORPORATION has announced the development of test equipment for use by programmers. The **Software Timing Checkout Unit Model 1700** is offered to programmers designing real-time operating systems. It permits a complete statistical analysis of any program, routine or sub-routine. Time is measured in intervals of one microsecond up to ten milliseconds. The longest time that can be measured is 9.999 seconds.

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For more information, circle No. 15 on the Reader Service Card

The Model 520 Display/Keyboard and the Model 724 Control Unit are the first in a series of data terminal systems announced by Computer Consoles, Inc. These units, together with an optional printer attachment, local storage magnetic tape unit, and standard magnetic tape, provide a unique combination for handling computer input, output and terminal display requirements.

The system may be operated locally as an independent information handling unit or as a data terminal system when connected to a proximate or remote data processing facility via cabling or transmission lines.

The 520 Display has a 14-inch CRT with 11.25" x 5.75" viewing area. Twelve lines with 80 character positions per line give up to 960 flicker-free characters per display.

The solid state detachable 520 Keyboard contains positions for 26 alphabetic, 10 numeric and 23 punctuation and special characters. A single or continuous advance multidirectional Cursor Control provides operator guidance during the insertion, shifting or deleting of a character(s), line or entire display.

When the system functions as a data input unit, verification of keyboard data entry may be employed by entering data a second time. This data is automatically compared with the first and verified.

The Model 724 Control Unit contains a 960 character buffer core storage and logic for keyboard or data processing facility instructions, and an additional 240

character buffer for the printer. For data communications a 202 C Data Set or equivalent may be used. Transmission rate is 1200 baud. Code is 7 level ASCII.

For more information, circle No. 16 on the Reader Service Card

A new disk storage drive, the ISS 701 has been placed on the market by Information Storage Systems, Inc. of Cupertino, California.

The minimum access time of the ISS 701 is 10ms., the average access time is 30ms., the maximum access time is 60ms., and the start up time is 15 seconds. The ISS 701 is said to have high reliability due to the use of an electromagnetic actuator and an electronic positioning control system. Also, electronics have been substituted for the least reliable mechanical parts, reducing particle generation and head-to-disk interference.

The 701 utilizes the IBM 1316 disc pack (or equivalent) as the storage medium and each pack has a storage capacity disk of 7.25 million bytes. Furthermore the 701 has a speed of 2,400 rpm, has 10 heads, and has 10 disk surfaces with a data transfer rate of 156,000 bytes per second. The operating environment for the machine is 60-90° F and 8-80% relative humidity.

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A multimillion byte core memory plug compatible with IBM 360/50, 65 or 75 has been announced by the Los Angeles based Data Products Division of Lockheed Electronics Company.

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By GEORGE N. VASSILAKIS

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PROBLEM OF THE MONTH

Submitted by Robert A. Howell

```
DØ 100 I = 1,20
If(I.NE.1.ØR.I.NE.3.ØR.I.NE.5) GØ TØ 100
WRITE(6,101) I
101 FØRMAT(5H I = ,I1)
100 CØNTINUE
WRITE(6,101) I
STØP
END
```

What values of I will be printed?

ANSWER TO LAST MONTH'S PROBLEM

The difficulty with this problem was that at execution time we would try to execute the statement 200 GØ TØ (101,102,101,102,101),K with K equal to -5.

Here is another area where FORTRAN compilers should do a little more to help the programmer. The most logical thing to do is to test the value of K and give a diagnostic if K is outside its range.

This problem was run on three different systems and here are the results:

CDC-6600

The following diagnostic was given at execution time:

ERROR, COMPUTED OR ASSIGNED GO TO STATEMENT

IBM-7094

The FORTRAN Compiler generates coding to test K for greater than 5 but not for less than 1. It uses an index register and the XEC instruction for branching to the various branch points. When XEC was executed with a -5 for K, it went back five instructions and executed the statement GO TO 400, which preceded the computed GO TO. Statement 400 was an arithmetic IF which in turn sent the program to statement 402 and printed the message given in FORMAT 8.

IBM-360

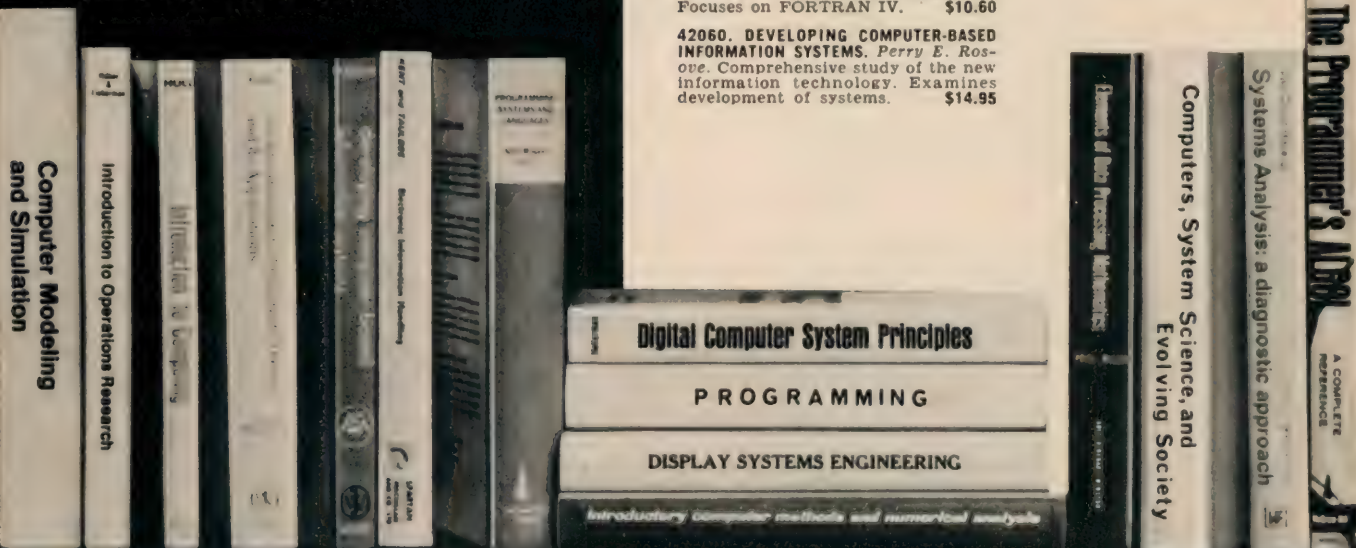
This compiler tests K and if it is outside its range it assumes $K = 1$ and executes the program without giving a diagnostic. If you try to complain you may be told that it is your responsibility to read (AND MEMORIZE) the manual, which clearly states that the compiler assumes $K = 1$ when K is outside its range. Of course, in a complicated problem you could have the wrong answers and never know that the index of a computed GO TO was outside its range.

P.S. If you feel that all compilers should generate coding to give better diagnostics at execution time please write to this editor so that you can be counted.

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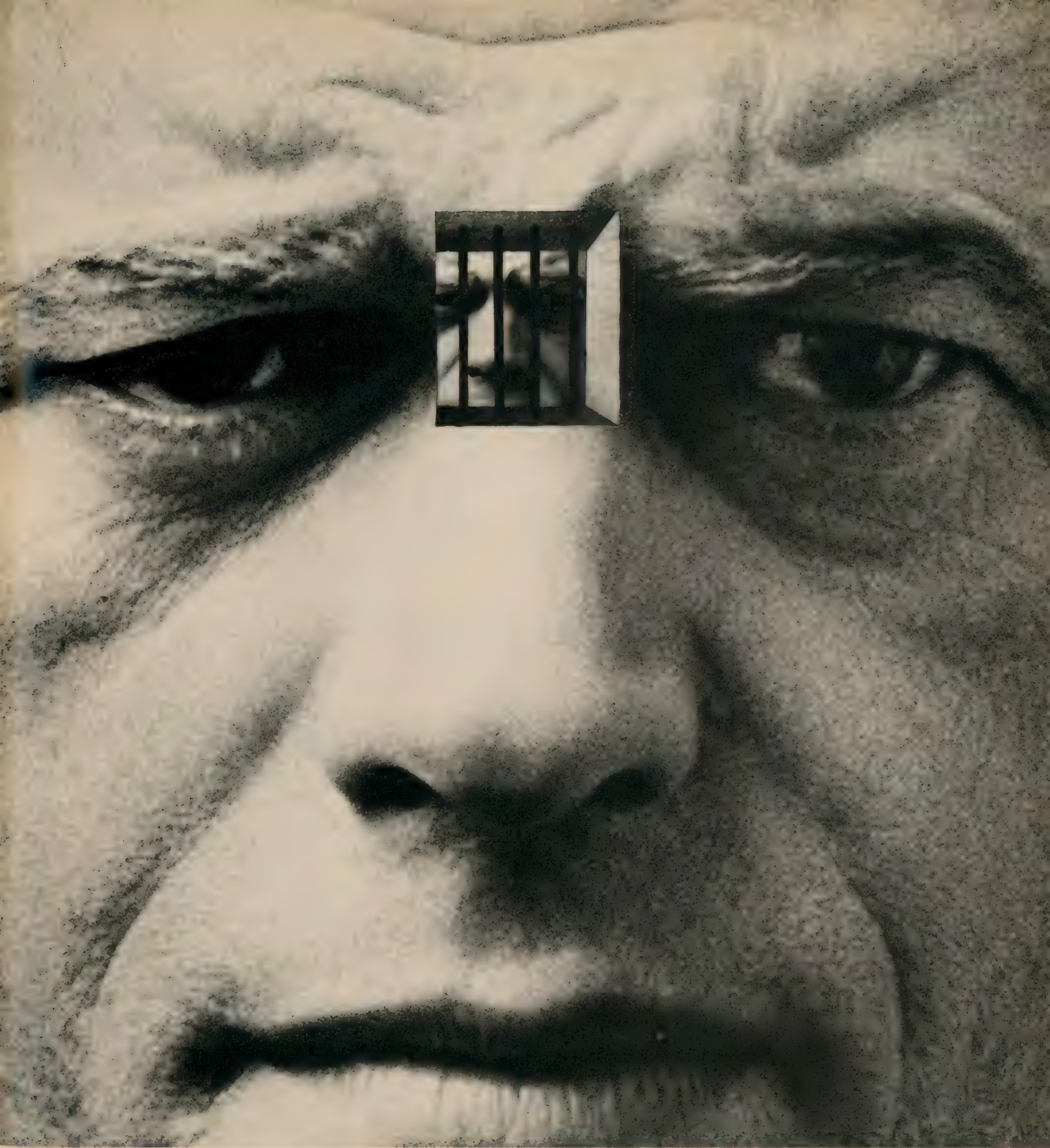
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CHECKMATE

(Continued from page 18)

Solution to Problem 7:

1 R-N1,P-R6; 2 R(N)-K1,K-N5; 3 R(K1)-K4 mate or P-Q6; 2 R(K)-N5,K-K5; 3 R(N1)-N4 mate

Solution to Problem 8:

1 Q-N1 threats 2 Q-R7ch,K-N5; 3 N-Q5 mate

1 Q-N1,K-R6; 2 Q-R1ch,K-N5; 3 N-R6 mate or K-N5; 2 N-Q5ch,K-R6; 3 Q-R1 mate or K-R5; 3 Q-R7 mate or B-B4; 2 QxB,P-N5; 3 Q-R7 mate or B-N5; 2 Q-Q4 etc.

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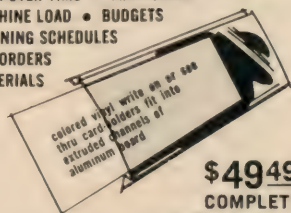
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As the size of systems grows, the implementation time grows and is laden with revisions. As the complexity of the system grows, the processing algorithms frequently become analysis and research efforts. The system design then becomes highly fluid and dependent upon these R&D outcomes. Management and the working analysts need some unit of systems design effort that can be scheduled, designed, and documented for independent evaluation. The Software Module can be designed and documented in just this fashion. In this form, the module can be the means of coordinating the various programs at an installation into something like a cybernetic whole. This paper addresses the problem of module design in a systems design context, including documentation and the management problems of visible progress, political priority and education.

Software Modulization

Part II

By Donald Ventner Mathusz

4.0 Module Design

The basic concept of a module involves a distinct processing function which is viewed as a closed system. The I/O passing over the boundaries of this system is rigorously defined in information content, allowable character sets and range; and field sizes and order per information block(s). The system design then consists of a net describing the modules as nodes and information flows between nodes. The concept easily enlarges to include material flows and sensors, exogenous inputs such as economic indexes and control loops with management intervention.

In the simplest case, one algorithmic function becomes a module. Whether this should be done constitutes a judgment decision influenced by available skills, scheduling and algorithm simplicity. In general, functions should be combined if they combine easily to produce one single parametric output. For example, if one algorithm is valid for one range of inputs but another must be looked to for output over the remainder of the input range, these two would

generally be likely candidates for combining.

Separation of modules occurs naturally when outputs are transferred from core to cards or tape, or a time phasing occurs such as a forecast based on actual previous forecast error. Size and logic complexity should also be considered in breaking up systems into processing modules. About 100 to 200 Fortran or Cobol statements including subroutines are enough for most revisions programmers to cope with effectively. If the processing logic is complex, it would be well to decrease this size. Program complexity is difficult to define, and so best evaluated by the management and systems people who must live with the system. Another point of natural separation is an algorithm requiring R&D. Here, we can isolate the effect of its development from the remaining easier portions of the system by designing it as an individual module. This facilitates the scheduling of manpower skills, i.e., we can keep our novice programmer busy on the defined programs while our mathematicians and operation researchers attack the R&D.

4.1 Heterogeneous Modules Interface Control

When several diverse installations follow modulization, they may still have significant problems in merging their modules for the common good. We will assume high order machine free languages were used in module packages as described in this paper. The problem that still remains is heterogeneous modules, i.e., modules with incompatible intermodule information transfers in field size, arrangements, precision et al.

One solution approach that can be used is to write a set of buffer subroutines, preferably disk filed for use by the main line. They may be indexed by two numbers, the module output number and module input number. If no buffer were needed, i.e. the intermodules data flows are homogeneous, the reference could be to a common non-active dummy subroutine via a table.

When a heterogeneous data flow buffer subroutine is called by the main line, its function is to either transform, select or stop data flows such that only homogeneous data is processed. Some of the programmed decisions might be:

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- Transform the data flow to homogeneity if possible and record alterations.
- Select the data which is homogeneous and flag operator, and print decisions concerning rejected data, e.g., values outside of permissible range.
- Flag the operator via real time upon problem status, and allow operator to make decisions in questionable cases.

The displays given the operator via scope, console typeout or other can be standardized along the module documentation lines listed in 4.0. The display routines are, of course, subroutines callable through the main line on a priority basis.

5.0 Module Documentation

We require two levels of documentation to keep our system in order. The higher level follows the system design net, where every node denotes a module. This master sys-

tem design plan then can serve as an index of access to the documentation of the individual module nodes. The nodes (modules) will be numbered and these numbers will connect the documentation between system and module plans. The cover sheet on the module documentation serves as its identification and index to other module or system interfaces.

The detail of the system software must always be clear and easily accessible to the working programmers and systems people to achieve the shortest revision time. When these people (perhaps new to the system) must spend as much time studying the program to make revisions as the original programming took, I think we can all agree we have a real problem.

The final important execution of this concept is the documentation of the module. This should follow a standard format and be executed while the programming is in progress and as each decision is made. The document's completion should

		1	2	3	4	5											
Data Specifications																	
Element		"I" Input	"O" Output	Field Size Positions	Format Reference	"A" Alpha	"B" Binary	"D" Del.	Variate Range—Low	"D" Discrete	"C" Continuous	Label Ref. Set No.	Tape Ref. Tape/Disk	Tape Channel	Disk Density	Data Reserve Ref. No.	Other Reference No.
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Table 1.

Table 1.

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be the milestone ending the programming activity associated with any particular module.

There are several devices which can be used to keep the actual writ-

ing time of the analyst down, e.g., checkoff matrices. The remainder of this paper will be used to show a suggested format for the documentation.

5.1 Cover Sheet—System Interface

The cover sheet should be used to identify this module's place in the total system mix of the installation.

Item	Comments
a) System Name	Descriptive of System's Function
b) Module Function Name and Number	Descriptive of Module's Function within the system
c) Language Specifications	Include Level and Compiler Revision Specifications
d) Machine & Peripherals requirements	Machine name, Core size, disks, tapes et al. actually required to operate this module
e) Input Source List	This list names each input to module by name and lists the system and module by names and numbers that it comes from. This includes non-EDP sources.
f) Output Sink List	This list names each output and the corresponding user or user system and module by name and number.

5.2 Exogenous Module Data Flow

The next section is concerned with specifying fully the exogenous and endogenous information flows of the module listed in *e* and *f* above. Much of this can be set up in a matrix format as shown below in *Table 1*.

Some Data Specifications need

more detail than can be contained in a matrix such as *Table 1*. The numbers at the head of the columns reference this kind of situation. An explanation of this with a suggested format for their elaboration is given below.

Element	Specification
1	1 This item would reference an actual format layout sheet showing the arrangement of fields required in the data flow.
2	1 Etc.
3	1
1	2 This item indexes a code reference set. This is, if letters or numbers, etc., are used to denote categories of information, their definition is done here in a list format.
2	2 Etc.
1	3 The label reference notation is used to identify the actual labels, headers and trailers required in tape and disk operations.
2	3 Etc.
1	4 The disk reserve numbers denote the specific areas upon the disk that are reserved for this information.
2	4 Etc.
1	5 Other detailed requirements may have to be spelled out in a format requirement needing more room than that supplied by the matrix. For example, report format samples could be included here.

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5.3 Endogenous Module Data Flow

The next area of definition is that of the internal data flows. This may be considered less critical in the sense that these internal flows are controlled wholly by the programming within the module itself. A suggested format for these is given below.

- a) *List Definition:* This list uses the actual program name symbols and then defines the information content.
- b) *Parameters and Constants:* This is a list by name and definition of values used in the module which are fixed and have some physical or legal meaning.
- c) *Subroutines:* This list contains all the subroutines, and an explanation of the function should be given here.
- d) *Algorithms:* This names and describes the function of all algorithms used in the module together with the assumption(s) involved.
- e) *Where used matrix:* This matrix shows the location of any of the above items within the module.

5.4 Revision Documentation

The next group of information needs is related to revisions. This includes the revision history, program listings and sample example problems and core dumps if relevant.

- a) Compiling time estimates.
- b) Program listing.
- c) Sample problem and running time.
- d) Important key logic statements or other notes for the revision programmer.
- e) Revision History: Each revision should be noted by date, authority and any notes relevant to it. If tables or other lists are affected, this should be so annotated on them with date, revision number and initials of the revision programmer. In some cases it may be better to add a new sheet. When this is done it should be marked as to its status just as the above changes and the old sheets kept for history but stamped obsolete.

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6.0 Summary of Module Uses

The problems and solutions discussed in this paper are not unique. The software module is used more or less by many systems analysts and systems designers. What this paper contributes is an analysis of the full range of usefulness of this concept from revision programming to management control. Below we itemize the particular points presented in this paper.

- Vehicle of implementing system parts for Visible Progress.
- Vehicle of implementing system parts for Political Priority.
- Vehicle of implementing system parts for management information and education.
- Scheduling Unit of independent work and management control.
- Vehicle of implementing system parts for Cost/Profit Priority Analysis.
- Basis for a master systems design toward a total system goal.
- Basis for a standard documentation.
- Basis for revision programmer's quick access to the system.

Bibliography

Very little seems to have been written about computer systems documentation as it affects the organization and management policy or how it is affected by the mode of system design in use. There are of course very specific bulletins about flow charting et al. generated by hardware manufacturers. There seems little point in listing these. A few papers and books bear on portions of this discussion, and so are listed here.

- Bennett, Degan, Spiegel, Editors, *Military Information Systems*, Praeger, 1964.
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- Van Horn, R. L., *Systematic Methods for Programming Simplification*, RAND, P2447, September 1961. ■

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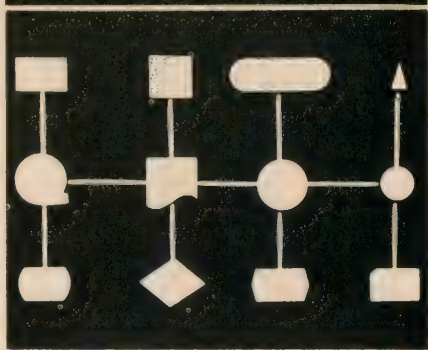
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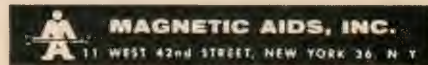


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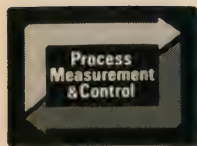
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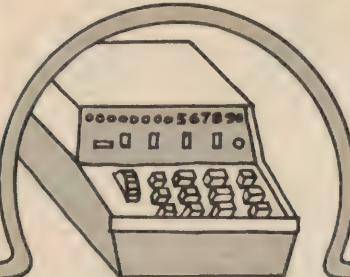


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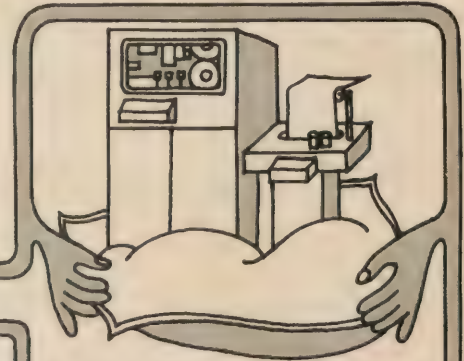
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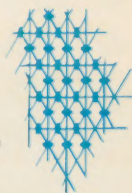
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